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REMOTE POSITION CONTROL OF LIGHTING UNIT

The present invention relates to a lighting unit, and a lighting system comprising a number of said lighting units.

It is well known to have lighting systems comprising a number of lighting units which allow the orientation of individual lamps to be adjusted, so that a required lighting effect can be obtained. Conventionally, the orientation of such lighting units has been adjustable manually, but this can be physically demanding and time consuming. Technology exists to allow this adjustment to be automated and controlled remotely. However, there are problems in producing such an automated system that has a simple and flexible means for selecting individual lamps for adjustment.

According to a first aspect of the present invention there is provided a lighting unit comprising: a number of individually moveable lamps; motor means configured to adjust the position of said lamps; controlling means configured to transmit drive signals to said motor means in dependence upon received control signals; and for each one of said lamps, a corresponding light detector, connected to said controlling means such that receipt of modulated light at one of said light detectors provides an indication to said controlling means that the position of the corresponding lamp is to be adjusted.

The invention will now be described by way of example only, with reference to the accompanying drawings, in which;

Figure 1 shows a lighting system comprises two lighting units and a portable remote control unit;

Figure 2 shows the remote control unit of *Figure 1* in more detail;

Figure 3 shows an alternative remote control unit to that of *Figure 2*;

Figure 4 shows schematically the main components of the remote control unit of *Figure 2*;

Figure 5 shows an isometric view of the lighting unit **101** of *Figure 1*;

Figure 6 shows the lighting unit **101** of *Figure 1*, removed from the lighting track;

Figure 7 shows the general physical layout of components within the body of lighting unit **101**;

Figures 8A and 8B show the tacho disc **712** and optical sensor **714** in a side view and an end view respectively;

Figure 9A and 9B show the home flag **715** and corresponding sensor **716** in a side view and an end view respectively;

Figure 10 shows the main electrical and electronic elements of the lighting unit **101**;

Figure 11 shows a flow-chart outlining the operation of the micro-controller of the lighting unit **101**;

Figure 12 shows, in further detail, the step **1104** of responding to control signals received from the infrared detector;

Figure 13 shows, in further detail, the step **1106** of responding to "position-select" control signals;

Figure 14 shows schematically the main components of an alternative remote control unit to that of *Figure 4*; and

Figure 15 shows schematically the main electrical and electronic elements of an alternative lighting unit, suitable for receiving commands from the remote control unit of *Figure 14*.

Figure 1

A lighting system is shown in *Figure 1.* The lighting system comprises two lighting units **101** and **102** and a portable remote control unit **103**. The lighting units **101** and **102** are alike, and each have a lamp housing, **111** and **112** respectively, which house lamps **121** and **122** respectively. The lamps in this example are halogen PAR36 lamps. However, other electric lamps which are capable of producing a beam of light may be used.

The lighting units **101** and **102** are attached to a conventional lighting track **104** from which they receive mains electricity. The lighting track **104** is itself mounted to the ceiling of the room that is occupied by the system's human operator **105**. The lighting system is suitable for illuminating any area where directed light is desired. For example the system is suitable for dining areas, art galleries etc. As will be understood from the following description, the operator **105** requires little technical understanding in order to adjust the lighting within the room.

The light units **101** and **102** each contain electric motors by which they are capable of individually panning and tiling their respective lamps. In addition, the units contain power control circuitry allowing the power supplied to their lamps to be individually varied, i.e. the lamps may be dimmed, or switched off. The panning, tilting and dimming of each lamp is controlled by the operator **105** using the remote control unit **103**.

In order to effect communication between the remote control unit **103**, and the lighting units **101** and **102**, the remote control unit emits two distinct types of radiation, and the lighting units have sensors which are arranged to detect these types of radiation. The first radiation type is modulated light, and

in the present example this takes the form of modulated laser light. The second radiation type in the present embodiment is modulated and coded infrared.

The two types of radiation have two distinct uses. The narrow beam of light is used by the operator to select a particular lamp which is to be adjusted. On selection of a lamp, the relevant lighting unit enters an activated mode in which it will receive and respond to commands received via the coded infrared. The infrared is therefore used to transmit command codes to a selected lighting unit regarding a lamp's movement, position, dimming etc.

For example, in order to adjust the orientation of a chosen lamp, in this case either the lamp **121** or **122**, firstly the lamp has to be selected, thus putting the relevant lighting unit into the activated mode. To do this, the operator presses a button on the remote control unit **103**, which results in the remote control unit generating a narrow beam of modulated light. In this example, the remote control unit **103** contains a laser diode which it uses to generate the light beam. This modulated light beam is directed by the operator **105** onto a light detecting sensor located on the under side of the chosen lighting unit. On receiving the modulated light at the sensor, the lighting unit illuminates a green light emitting diode (LED) to indicate to the operator that the lamp has been selected, and the lighting unit enters its activated mode.

Thus, the beam of light used to select a lamp has to be sufficiently narrow so that it may be shone onto a particular sensor without illuminating other light sensors corresponding to neighbouring lamps.

On observing the illuminated green LED, the operator then selects and presses a second button on the remote control. By pressing the relevant

button, the operator may command the lighting unit to pan the selected lamp clockwise or anticlockwise, tilt the lamp up or down, dim the lamp up or down, or switch the lamp off or on. While adjusting the position of the lamp, the task is usually made easier if the operator can observe the beam produced by the lamp rather than the lamp itself. For example if the lighting unit is used in an art gallery, the operator may watch the beam of light as it is moved towards a sculpture. For this reason, the infrared transmitted by the remote control unit **103** is a broad beam, allowing the operator to make adjustments without having to be too accurate when pointing the remote control towards the lighting unit.

It should be noted that the two lighting units are manufactured to be indistinguishable, and are arranged to receive and respond to the same modulated light as each other, the same infrared as each other, and the same codes carried by the infrared as each other. Nevertheless, because each lamp is selectable by the modulated laser light, the movement and brightness of each lamp is individually controllable.

Furthermore, it may now be understood, that if there was requirement for additional lighting units, then units similar to units **101** and **102** may be connected to the lighting track, or another lighting track within the room, and operated on an individual basis using the same remote control. This is done without the need for rewiring or reprogramming of the lighting units or the remote control unit **201**, because all lighting units, such as **101**, of a system respond to the same type of modulated light and the same infrared codes. I.e. the lighting units do not have to be programmed with an identity code which identifies them before being installed within a system. Therefore, the lighting system may be expanded to include an unlimited number of such

lighting units.

In addition to controlling lamp movement etc., by pressing another button on the remote control unit **103**, the operator is also able to store information defining the current orientation of the lamp, or move the lamp to a position defined by stored information. For example, the operator **105** may frequently require the lamp **121** to be repositioned to one or more particular orientations, and thus, having positioned a lamp in an orientation which is considered useful, the operator may command the lighting unit to store information defining this orientation. Then, in the future, when that same orientation is required again, the operator may command the lighting unit to recall the stored information and thus cause the lighting unit to move the lamp to said orientation.

Figure 2

The remote control unit **103** of *Figure 1* is shown in detail in *Figure 2*. The remote control unit **103** is of a size and weight which allows it to be easily carried by hand. The laser diode (not shown in *Figure* 2) and the infrared LED (not shown in *Figure* 2) are mounted at a front end **201** of the remote control unit, so that when energised, their respective beams extend forward from said front end. The remote control unit **103** has a single button **202** which is depressed to energise the laser diode, and is held down while the operator directs the laser beam onto the sensor of a chosen lamp. Located adjacent to button **202** there is a button **203** for panning clockwise, a button **204** for panning anticlockwise, a button **205** for tilting up, and a button **206** for tilting down. In addition, there are buttons for dimming up, **207**, dimming down, **208**, and switching the lamp on and off, **209**.

Therefore, if the orientation of any chosen lamp is to be adjusted, the operator simply presses the laser button **202** and directs the laser beam at the sensor corresponding to the chosen lamp, then having observed from the lighting unit's LED that it has been selected, the operator presses the relevant one of the four positioning buttons **202** to **205**.

The remaining four buttons **210**, **211**, **212** and **213**, on the upper surface of the remote control unit **103**, are concerned with the storing and recalling of useful lamp orientations and dimmer settings. The remote control unit also has a liquid crystal display (LCD) **214** which facilitates the use of these four buttons. The lighting units **101** and **102** are each capable of storing information defining twenty-three different lamp orientations/dimming control settings. Therefore, when a lamp has been manoeuvred to a useful position, which is to be stored, the operator must first select a number between one and twenty-three that will identify that position. This number selection is carried out by depressing a pre-set up button **210** or a pre-set down button **211**, as appropriate. Depression of these buttons causes the number displayed by the LCD **214** to increase and decrease, respectively, within the range one to twenty-three. When the desired number is selected and displayed by the LCD **214**, the operator then presses the record pre-set button **212**. This action has the effect of putting the controller in a record mode. The operator then presses a send-pre-set button **213** which causes the remote control unit **201** to transmit coded infrared to the currently activated lighting unit, commanding the unit to store information defining its present orientation and dimmer control setting within its memory location that is identified by the selected number.

Having stored positional data in this way, the operator may then reposition a chosen lamp by firstly selecting the lamp by means of the laser, selecting the stored position by selecting the relevant number using the buttons **210** and **211** and LCD **214**, and then pressing the send-pre-set button **213**. On pressing button **213**, the remote control unit **201** transmits coded infrared which commands the lighting unit to recall positional data, and dimmer control data, from its relevant memory location, and then to move the selected lamp to the defined position and adjust the dimmer setting as required.

The lighting units **101** and **102** are configured to receive infrared code even when they have not been selected by modulated light, but until a lamp of a lighting unit has been selected, the lighting unit will not respond to received commands. As well as being selected by receiving the modulated light, a lamp is selected when the infrared sensor of a light unit receives a "select-all" code. Because the infrared is transmitted as a relatively wide angled beam, this means that several, or all, lighting units may be selected at once. The lighting units are configured such that if they are selected in this way, they will respond to commands to recall positional data from their memory, and move their lamp to the relevant pre-defined position.

For this purpose, a pair of "select-all" buttons **215** and **216** are located on opposing sides of the remote control unit **103**. When the "select-all" buttons **215** and **216** are pressed simultaneously, the remote control unit **103** transmits a "select-all" code by means of its infrared LED.

Therefore, for a particular lighting arrangement, the operator **105** may store positional data for each lighting unit on an individual basis within, for example, memory location number 10. Then, when the same lighting

arrangement is required again, the operator may select all of the lighting units by pressing "select-all" buttons **215** and **216**, then select the number 10 on LCD **214** before pressing the send-pre-set button **213**. Thus, all lighting units can be made to return to pre-set positions simultaneously.

In an alternative lighting system, the lighting units are configured to store ten sets of positional data and dimmer setting control data in memory locations identified as one to ten. However, other memory locations are used to store time intervals relating to movement sequences. For example, a memory location identified as "11" may store a time interval of 10 seconds while a memory location "12" may store a time interval of twenty seconds, etc. If such a lighting unit then receives a command from a remote control unit to recall pre-set data "11", it interprets such a command as a command to step through a number of stored positions. The lighting unit retrieves the time period of ten seconds from memory location "11", it then retrieves data from memory locations one to ten and moves the lamp through the corresponding positions, with a ten second delay between each movement. Similarly, if a recall pre-set data "12" command is received, the lamp is again stepped through positions defined by data in memory locations one to ten, but this time with a twenty second delay between lamp movements. By providing the lighting units with this ability to move their lamps through pre-defined positions, the system is able to produce a dynamic lighting display.

Figure 3

An alternative remote control unit **301** to that of *Figure 2* is shown in *Figure 3*. The appearance of remote control unit **301** is similar to unit **103**, except that it does not have a LCD, or the four buttons used for storing and

recalling positional data, or the "select-all" buttons. Therefore, it only has a laser activation button **302**, four movement control buttons **303**, **304**, **305**, and **306**, dim-up button **307**, dim-down button **308** and on/off button **309**, which have similar functions to the corresponding buttons **202** to **209** of unit **103**.

The remote control unit **301** may also be used with the lighting system of *Figure 1*, ie with lighting units such as **101** and **102**, in instances where a less sophisticated controller is required. For example, the operator **105** may be responsible for setting up pre-set positions and so uses remote control unit **103**, while other operators, who may be less skilled, use the simpler control unit **301** to make adjustments to individual light units.

Figure 4

The main components of the remote control unit **103** of *Figure 2* are shown schematically in *Figure 4*. The remote control unit **103** comprises an eight bit RISC-like micro-controller **401**, which has in built program memory PROM (programmable read only memory) containing the unit's operating instructions, and one hundred and sixty bytes of in built RAM (random access memory). A suitable micro-controller is sold by Holtek as part number HT48R50A-1. The micro-controller **401** receives inputs from button switch array **402** comprising the fourteen buttons **202** to **213**, **215** and **216**. In dependence of received inputs from the button array the micro-controller provides suitable output signals to the LCD **214**, the laser diode module **403** or the infrared LED **404**.

The laser diode module **403** in the present example is an LM-01 laser module sold by Eubon Technology Co. Ltd. and during operation it receives a

signal from the micro-controller **401** causing it to switch on and off at a frequency of one kHz (kilo-Hertz). I.e. it transmits laser light modulated at a frequency of one kHz.

The infrared LED **404** is a sold by Vishay as IR LED type TSUS540. The micro-controller **401** generates control signals by coding a thirty-eight kHz modulated signal, and these control signals are converted to, and transmitted as, an infrared beam by the infrared LED.

Figure 5

The lighting unit **101** of *Figure 1*, is shown in greater detail in the isometric view of *Figure 5*. The lighting unit comprises a body **501** connected by a drive shaft to the lamp housing, and by a second drive shaft to a lighting track connector **502**. The lighting unit **101** is connected to the lighting track **104** by means of the lighting track connector **502**. In this example the lighting track is manufactured by Eutrac.

As well as receiving mains electricity from the lighting track **104**, the connector **502** also supports the weight of the lighting unit **101**. Furthermore, the connector **502**, when fixed into the lighting track, provides an anchor about which the body **501** and lamp housing **112** can rotate, and thus, panning of the lamp **112** is performed. Tilting of the lamp **112** is simply performed by the lamp housing rotating with respect to the body **501**.

The lighting unit **101** is shown in *Figure 5* in, what is referred to as, its 'home' position, with its body parallel to the track **104** and its lamp housing directing the lamp downwards. As will be described, the lamp is arranged to be able to orientate itself to the 'home' position, and stored positional data is determined with respect to this position.

A flat window **503** is located in the underside of the body **501**. The window **503** is transparent to visible light and infrared light at the wavelengths transmitted by the laser diode and infrared LED of the remote control unit **103**. Thus, the window **503** allows access of the laser light and infrared to sensors located behind the window.

The green LED **504** which is illuminated when the lamp **112** is selected is also located on the underside of the body **501**.

In an alternative embodiment the window **503** is shaped to define a pair of lenses arranged side by side, and configured to focus incoming radiation onto the two sensors.

Figure 6

The lighting unit **101** of *Figure 1* is shown removed from the lighting track in *Figure 6*. The light unit **101** is a self contained module which can be easily connected and disconnected from a lighting track by means of its connector **502**. Therefore, as described earlier, the number of such units included within a track light system may be simply adjusted. In addition, if for any reason a lighting unit requires replacement, this may be done very simply and quickly by unclipping one unit from the track and clipping in a new unit. Furthermore, because the connector **502** is of a conventional type, the lighting unit **101** may be used to replace an existing static type lighting unit within an existing lighting system, without further alteration to that system.

Figure 7

The general physical layout of components within the body of lighting unit **101** is shown in *Figure 7*. Electric cables **701** connect the terminals of the

connector **502** with power supply circuitry **702** within the body **501**. The cables **701** enter the body **501** through a hollow drive shaft **703** which connects the connector **502** to the body. The power supply circuitry **702** supplies a regulated voltage to control circuitry **704**, and it also contains a transformer which supplies power to the lamp **121** by means of cables which pass through a second hollow drive shaft **753**.

For the purposes of simplicity and clarity, other electrical connections have been omitted from *Figure 7* but further detail of this is provided later with respect to *Figure 9*.

As described previously, the green indicating LED **504** is located in the lower wall of the body **501**, and the infrared sensor **706** and the light sensor **707** are located behind window **503**.

The drive shaft **703** is located within bearings so that it may be rotated with respect to the body **501**, while it is rigidly attached to connector **502**. Thus, in operation the body is rotated by driving the shaft **703**. Shaft **703** supports a spur gear **708** which meshes with a drive gear **709** such that, on rotation of the drive gear, the shaft **703** is driven. The drive gear **709** is itself driven by an electric motor **710** via reduction gear **711**. The electric motor **710** and reduction gear **711** is a single unit which is configured to rotate the drive gear **709** at approximately eight revolutions per minute when the motor receives twelve volts. In addition to providing the required torque, the gear **711** also ensures that the lamp does not pan when power has been removed from the motor **710**.

A slotted tacho disc **712** is rigidly fixed to a back shaft **713** which extends from the rear of the electric motor **710**. The tacho disc **712** is located within an optical sensor **714** connected to the control circuitry **704**. The

optical sensor **714** supplies panning movement information to the control circuitry when the motor operates.

A single slotted disc **715**, referred to as the home flag, is rigidly attached to the end of the drive shaft **703**. A second optical sensor **716** is positioned so that the home flag rotates through it, as shaft **703** rotates. By means of the optical sensor **716** and the home flag **715**, limited rotational positional information is supplied to the control circuitry, such that the control circuitry is able to rotate to shaft **703** to the home position.

The drive shaft **753** which is used to tilt the lamp **122**, is similar to drive shaft **703**, and therefore has similar, and corresponding, home flag **765**, with optical sensor **766**, spur gear **758**, driven by drive gear **759**, itself driven by electric motor **760** via reduction gear **761**, electric motor back shaft **763** supporting tacho disc **762** having an associated optical sensor **764**. In a similar manner to gear **711**, reduction gear **761** provides the required torque to tilt the lamp under the power of the motors, while preventing further tilting when the motors are not being driven.

Figures 8A and 8B

The tacho disc **712** and optical sensor **714** are shown in detail in the side view and end view of *Figure 8A* and *8B* respectively. The tacho disc **712**, attached to back shaft **713**, is a circular disc containing ten slots **801** extending radially inward from its outer edge and thus defining ten radial spokes **802**. The sensor **714** comprises an LED **803** and a photodiode **804** which are positioned so as to face opposing sides of the disc **712**. As the disc rotates and spokes **802** pass in between the LED **803** and photodiode **804**, the photodiode generates a corresponding signal which is supplied to the

control circuitry **704**. Thus control circuitry **704** receives a signal which provides information of the rotation of the motor **710**.

Figures 9A and 9B

The home flag **715** and corresponding sensor **716** are shown in detail in the side view and end view of *Figure 9A and 9B* respectively. The sensor **716** is of the same type as sensor **714**, having an LED **903** and a photodiode **904**, which face opposite sides of the home flag **715**.

The home flag **715**, which is fixed to the end of shaft **703**, takes the form of a disc from which the outer portion has been removed from one half. Therefore, the disc has a small radius for one half **905** and a larger radius for its other half **906**. The difference in the radii of the two halves is such that as the flag **715** rotates, the larger half **906** of the flag comes between the LED **903** and photodiode **904** for half of a revolution while nothing comes between them for the other half of the revolution. Consequently, as the shaft rotates the photodiode supplies a voltage to the control circuit which depends upon the position of the shaft. Furthermore, two edges **717** and **718** define positions where the radius of the disc changes from the smaller to the larger radius, and by monitoring the voltage from the photodiode **904** these edges are detected. The home position of the shaft **703**, and hence the home position for the lighting unit is therefore chosen in respect to one of these edges.

Figure 10

The main electrical and electronic elements of the lighting unit **101** are shown schematically in *Figure 10*. Mains electricity, received by the track

connector **502**, is supplied to a power supply **1001** and thyristor circuit **1002**. The power supply **1001** is configured to supply suitably regulated voltages to the electronic control circuitry within the lighting unit **101**, including the micro-controller **1003**, electrically erasable programmable read only memory (EEPROM) **1004**, and driver circuitry **1005**.

The thyristor circuit **1002** is configured to control a voltage supply to a lamp transformer **1006** in response to a signal received from the micro-controller **1003**. Thus, a voltage between zero and mains voltage is supplied to lamp transformer **1006**. The lamp transformer **1006** is configured such that, when it receives mains voltage, it supplies a voltage of twelve volts to the lamp **121**, ie it supplies a voltage within the lamp's rating.

The micro-controller **1003** is an eight-bit RISC-like micro-controller designed for multiple input/output applications. A suitable micro-controller **1003** is sold by Holtek under the part number HT48C50A-1. The micro-controller **1003** has one hundred and sixty kilo-bytes of in-built random access memory (RAM). It also has programmable read only memory (PROM) containing the process instructions for the operation of the lighting control unit **101**.

The micro-controller receives signals from the optical sensors **714** and **764**, providing the micro-controller **1003** with data regarding the rotational movement of the motors **710** and **760** respectively, and signals from the optical sensors **716** and **766** which indicate to the micro-controller when the drive shafts **703** and **753** are in their home positions. The micro-controller also receives signals from the infrared sensor **706** and the light sensor **707**. The light sensor in the present embodiment is a photodiode supplied by Vishay under part number BPW34, and a suitable infrared sensor is sold by

JRC under part number NJL61V380.

The micro-controller is also able to supply signals to, and receive signals from, the EEPROM **1004**. Thus, positional data and dimmer setting information may be stored on the EEPROM, and then retrieved, even after a discontinuity in the power supply. For example, during use the present dimmer setting of a lighting unit is stored in the EEPROM, so that when said lighting unit is first switched on, the last used dimmer setting can be looked up and relevant signals applied to the dimming thyristor circuit **1002**.

The micro-controller **1003** is also configured to output signals to driver circuitry **1005**. The driver circuitry **1005** comprises of power transistors for supplying voltages to the motors **710** and **760** in response to the signals received from the micro-controller.

Figure 11

A flow-chart outlining the operation of the micro-controller of the lighting unit **101** is shown in *Figure 11*. After receiving power at step **1101**, the micro-controller **1003** retrieves the last used dimmer setting from the EEPROM **1004** and supplies corresponding signals to the thyristor circuitry **1002** at step **1102**, thus causing the thyristor circuitry to supply the required power to the lamp **121**. Thus, when the lighting unit first receives power, the lamp of the lighting unit is switched on with the dimming setting which was used just before the lighting unit was switched off. At step **1103**, a question is asked as to whether a correctly modulated signal, ie a one kHz modulated signal, has been received from the photodiode **707**. If this question is answered yes, the micro-controller responds to subsequent control signals received from infrared detector **706** at step **1104**, before entering step **1105**.

Otherwise, if the question at step **1103** is answered no, then step **1105** is entered directly.

At step **1105**, a question is asked as to whether a "select-all" code has been received from the infrared detector **706**. If this question is answered no, the process re-enters step **1102** directly. If this question is answered yes, then the process enters step **1106** before re-entering step **1102**. At step **1106**, the micro-controller **1003** responds to "position-select" control signals received from the infrared detector **706**. These signals cause the micro-controller to retrieve position data and dimmer setting data stored in EEPROM **1004** and control the lamp's position and power setting in a corresponding manner.

Thus, the micro-controller can be activated by the photodiode, to respond to infrared control codes on an individual basis at step **1103**, or activated by the infrared detector to respond, as part of a group, with micro-controllers of other lighting units at step **1105**.

Figure 12

The step **1104** of responding to control signals received from the infrared detector is shown in further detail in *Figure 12*.

The micro-controller **1003** is configured to respond to control signals, received via the infrared detector, after modulated light has been received at the photodiode at step **1103**. However, if control signals are not received for a pre-defined period of time, then the micro-controller is configured such that it will not respond to control signals again, until it has been re-activated at step **1103**. Therefore, in order to monitor how recent control signals have been received, at step **1201** a timer is started.

A question is then asked at step **1202** as to whether a movement control signal has been received. If a movement control signal has been received, the process enters step **1203** in which drive signals are transmitted to the relevant motor until a movement control signal is no longer received from the infrared detector. When the movement control signals are no longer being received, the drive signals are stopped. In addition, the timer started at step **1201** is re-started before step **1204** is entered.

If it is determined at step **1202** that a movement control signal has not been received then the process enters step **1204** directly. At step **1204** a question is asked as to whether a control signal relating to dim up, or dim down, or on, or off has been received. If such a signal has been received, corresponding signals are transmitted to the dimming thyristor circuit **1002** at step **1205**, and the timer restarted before step **1206** is entered. Otherwise, step **1206** is entered directly from step **1204**.

At step **1206** it is determined whether a control signal has been received from the infrared sensor, commanding that data defining the current position should be stored. If there has not, then step **1210** is entered directly, but if there has, then step **1207** is entered.

At step **1207** it is determined whether the current orientation of the lamp is known. The position of the lamp is only known if the lamp has been put in the home position since power-on, at step **1101**. This is because the position of the lamp is calculated from movement data received from optical sensors **714** and **764** since the last time the lamp was in the home position. If the lamp's current position is known, then step **1209** is entered directly, but if it is not known, then the process first enters step **1208** before entering step **1209**.

At step **1208**, under the control of the micro-processor, signals are supplied to the motors until the home position is reached. By monitoring the data from sensors **714** and **716** during this movement, data defining the "current position" is found. After determining the "current position" data, the lamp is moved back to the "current position".

At step **1209** positional data of the lamp's current position is stored, along with data defining the lamp's present dimmer setting.

At step **1210** a question is asked as to whether a "position-select" control signal has been received from the infrared detector. If such a signal has been received, then the micro-controller responds to the received "position-select" control signal at step **1211**, before entering step **1212**. Otherwise, the process enters step **1212** directly from step **1210**. The step **1211** is similar to step **1106**, and will be described in detail with respect to *Figure 13*.

At step **1212** a question is asked as to whether the timer has reached a pre-defined time. If the timer has reached the pre-defined time, this indicates that the operator **105** has not used the remote control unit **103** to adjust the lamp's settings within the pre-defined period, and step **1104** is exited. However, if the pre-defined time has not been reached by the timer then the process enters step **1213**. At step **1213** a further question is asked to determine whether a "de-activate" control signal has been received indicating that the operator no longer requires the micro-controller to respond to control signals. If this is answered yes then the process exits step **1104**, otherwise step **1202** is re-entered.

Figure 13

The step **1106** of responding to "position-select" control signals is shown in detail in *Figure 13*. Firstly within step **1106**, at step **1301**, the micro-processor receives "position-select" control signals from the infrared receiver which identify the memory location containing the required positional data and dimmer setting data. At step **1302** the stored positional data and dimmer setting data is retrieved from the memory location identified at step **1301**. At step **1303**, a question is asked as to whether the current position of the lamp is known. If this question is answered yes then step **1305** is entered directly, otherwise the process first enters step **1304**. At step **1304**, under the control of the micro-controller, drive signals are transmitted to the motors to move the lamp to the "home" position. The current position is then known since it is the "home" position. At step **1305**, a calculation is made to determine the required movement to move the lamp from the current position to the required position, defined by the data retrieved at step **1302**. At step **1306**, under the control of the micro-controller, drive signals are transmitted to the motors to move the lamp to the required position.

In response to dimmer setting data retrieved at step **1302**, the micro-controller transmits signals to the thyristor circuitry **1002** causing said circuitry to supply the required power to the lamp, thereby producing the required dimmer setting. Upon completion of step **1306**, step **1106** is completed and the process re-enters step **1102**.

Figure 14

It should be understood, that light is used to select a lamp because its visibility allows the narrow light beam to be accurately directed towards the

photodiode of the lighting units. However, once a lighting unit has been selected, it is then desirable for the radiation carrying the control signals to comprise of a wide beam so that operator accuracy is not necessary. In the main embodiment the wide beam of radiation was an infrared beam. However, in an alternative embodiment radio waves are used in place of infrared.

The main components of an alternative remote control unit to that of *Figure 4* are shown schematically in *Figure 14*. The remote control unit of *Figure 14* is substantially the same as that of *Figure 4*, except that the infrared LED **404** is replaced by a radio frequency generator **1401**, a modulator circuit **1402** and an aerial **1403**. The modulator circuit **1402** is configured to modulate a radio frequency signal received from radio frequency generator **1401** using control signals received from the micro-controller **401**, and thus generate a modulated radio frequency signal. The radio frequency signal is then transmitted to lighting units via the aerial **1403**.

Figure 15

The main electrical and electronic elements of an alternative lighting unit, suitable for receiving commands from the remote control unit of *Figure 14*, are shown schematically in *Figure 15*. The lighting unit of *Figure 15* is substantially the same as lighting unit **101**, of *Figure 10*, except that the infrared receiver **706** is replaced by an aerial **1501** and a receiver circuit **1502**. Thus, the components of the lighting unit of *Figure 15*, which are the same as those of *Figure 10* have been given the same numerical label.

The receiver circuit **1502** receives a modulated radio frequency signal from the aerial **1501**, and from this signal it retrieves the modulating signal,

i.e. the control signal. The modulating signal is then transmitted to the micro-controller **1003**, where it is decoded.

Other operations of the remote control unit of *Figure 14* and the lighting unit of *Figure 15* are the same as the remote control unit **103** and lighting unit **101** respectively.

In a further alternative embodiment of the present invention, the lighting unit has a second individually moveable lamp and a corresponding second photodiode, connected to the micro-controller, for receiving the one kHz modulated light. The lighting unit enters its activated mode on receipt of the modulated light to either of its two photodiodes, but only the lamp corresponding to the receiving photodiode becomes selected. Thus, when activated, the lighting unit receives control signals from its infrared detector, and responds by moving, dimming etc. the lamp whose corresponding photodiode received the modulated light.

Therefore, like the lighting unit of the main embodiment, it is configured such that any of its independently moveable lamps may be selected by receipt of modulated light to a light sensor, and then orientated on receipt of control signals received in the form of coded infrared. This simplicity of operation is facilitated by the provision of a corresponding light sensor for each of the individually moveable lamps.

In a further alternative lighting system, said system also includes an alternative remote control device in additional to a remote control unit such as unit **201** or the remote control unit of *Figure 14*. The alternative remote control device is configured to transmit the "select-all" and "position-select" commands in the same manner as the remote control unit, ie by codes transmitted over a radio link or by infrared, as appropriate. However, the

Device is also configured to be programmed to store a sequence of moves entered on its keypad, or received from a distant computer over a bus system. Once programmed, the alternative remote control device is configured to periodically transmit commands to the lighting units of the system, and thereby move the lighting units through the programmed sequence of movements, without any further human, or computer, input. The device may also be configured to transmit commands to the lighting units in response to commands it receives from a distant computer over a bus system.

It was mentioned at the beginning of the description that standard, eg. halogen PAR36, lamps may be used as the lamps 121, 122 in the lamp housings 111, 112 respectively. These may give white light in their unmodified form, or may alternatively provide coloured light, eg. red, green or blue, by the addition of filters placed adjacent the lamps. The filters will be movable and will be controlled from the microcontroller 1003 shown in Figure 10 in response to coded input from the remote control unit.

An alternative way of providing different coloured light from the lighting units is to employ discrete lamps instead of discrete filters. Where space is at a premium as regards the lighting unit, such lamps may be smaller than the equivalent lamp used in isolation and will be differently coloured - eg., as just mentioned, red, green and blue. In place of standard-type lamps, light-emitting diodes (LEDs) may be employed. Whatever form of lamp is used, they will be controlled by the microcontroller, as with the case of the moveable filters.